MARICOPA ASSOCIATION of GOVERNMENTS

MAG ITS Strategic Plan Update

Technical Memorandum #5

- MAG Regional ITS Architecture

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Technical Memorandum No. 5

1.0 INTRODUCTION AND BACKGROUND

Technical Memorandum Number 5 summarizes the efforts of Task 8 of the MAG ITS Strategic Plan Update, *Develop Regional ITS Architecture*.

An architecture provides the ability to accommodate technology changes, evolution, and growth of the system. Rather than installing technologies and implementing systems in a piecemeal fashion, it is important to have a plan and a framework in which the various systems will be designed and integrated to satisfy regional goals and objectives. By establishing this framework (the regional ITS architecture) to deploy ITS systems in the MAG region, the MAG ITS Committee will be able to select future projects that meet both local jurisdiction needs and regional goals, and comply with Federal funding requirements.

The MAG Regional ITS Architecture is based on the identified needs of transportation users in the MAG region, and their associated User Services and Market Packages as defined in the National ITS Architecture. User needs were identified in Technical Memorandum Number 3 of the MAG ITS Strategic Plan Update. User Services and Market Packages for the MAG region were identified in Technical Memorandum Number 4. Development of the MAG regional architecture also involved close coordination with the existing statewide architecture for Arizona, the AZTech™ architecture, and the Freeway Management System (FMS) architecture.

The purpose of the MAG regional ITS architecture is to ensure that an integrated ITS system is deployed in the MAG region. To this extent, future projects recommended in Task 10, Develop an ITS Implementation Plan, will be developed in conjunction with the MAG regional ITS architecture and will include the appropriate communications links among the architecture subsystems. The process of ensuring consistency with the architecture for ITS projects deployed in the MAG region will ensure that an integrated ITS system continues to be deployed into the future. Specifically, the MAG regional ITS architecture will:

- Identify the different transportation management systems in the MAG region and how they will interact;
- Allow multiple agencies, service providers and users to communicate;
- Show responsibilities of different organizations and service providers involved in the system;
- Identify communications and data flows among participants;
- Support the development of open systems (i.e., systems with interfaces that use standard or known communication protocols);
- Incorporate existing and planned systems;
- Accommodate new technologies in the future;
- Provide a framework for multiple design choices; and
- Provide structure for future planning and growth.

The first part of this Technical Memorandum provides basic definitions used in describing the National ITS Architecture. A general description of the methodology used in defining an architecture also is presented.

The logical architecture for the MAG region is then described. The logical and physical architectures are closely related, and a detailed description of the existing and future physical architectures are provided. Existing and recommended subsystems for deployment are also described. An ITS architecture vision is presented that describes the subsystems and connections that are recommended for deployment to satisfy the identified user needs, user services and market packages for the MAG region as described in Technical Memorandum Number 4. An institutional architecture is also presented to describe the institutional arrangements necessary to fully support the future architecture.

Finally, a description of developing and new technologies that should be considered in the MAG region is provided.

2.0 DEFINITIONS

The proposed MAG Regional ITS Architecture presented in this Technical Memorandum was developed using the National ITS Architecture (NA) concepts and nomenclature. The following are terms frequently used throughout this Technical Memorandum to describe the data, processes, and infrastructure that form the existing and future elements of MAG's regional ITS architecture.

User services describe ITS should do based on the user needs. User services for the MAG region were identified in Technical Memorandum Number 4.

The ***logical system architecture*** defines what needs to be done to support the selected user services. It does so through the use of ***processes***, which perform ITS functions; ***terminators,*** and connecting ***data flows*** that are needed to support those user services. Many different processes must work together and share information to provide a user service. Data flows identify the information that is shared by the processes.

The ***physical architecture*** provides a high-level definition of the major system components and interfaces and makes use of three "layers" to describe all of its elements: the ***transportation*** layer, the ***communications*** layer, and the ***institutional*** layer. The transportation layer definition is based on a standard set of ***subsystems***, ***terminators***, and their connecting ***architecture flows***:

- The 19 currently defined ***subsystems*** are the principal elements of the physical architecture. These subsystems correspond to physical, real or mobile infrastructure such as traffic management centers, vehicles, and traffic signals. A definition of the 19 subsystems is provided in **Appendix A**.
- ***Terminators*** represent elements that are external to the architecture such as people, systems, other components of the external environment that interface with the architecture. No functional requirements are associated with the terminators. The same set of terminators is used for both the logical and physical architecture definitions.
- ***Architecture flows*** show data or information that is exchanged among subsystems and terminators. They comprise one or more data flows present in the logical architecture. Together with communications requirements, which are typically provided with each architecture flow, they facilitate the early selection of system interface standards.
- The ***communications layer*** comprises all of the communications equipment and information management and transport capabilities that are needed to transfer information between entities in the transportation layer.

The ***institutional layer*** of the physical architecture represents the institutional constraints and arrangements that exist or will exist in the MAG region that form the context in which the architecture elements will be deployed. This layer deals with policies, funding incentives, working arrangements, and jurisdictional structure that support the technical layers of the system architecture (both transportation and communications). Roles and responsibilities of the system implementers are defined in this layer.

Approved ***standards*** provide technical specifications, guidelines, and definitions used in the design of an open system architecture.

3.0 METHODOLOGY

The methodology employed in this task followed the architecture development process supported by the "natural" relationships and dependencies of the various architecture elements. To begin, the inventory of existing ITS elements in the MAG region was used to lay out a high-level representation of the physical architecture that is currently in place.

Next, a high-level logical architecture was developed that would address the system objectives identified in the previous task. The processes and data flows of the logical architecture were selected to address the specific transportation needs expressed by the previously identified user services. Section 4.0 of this Technical Memorandum documents the process of developing the logical architecture. In the following step, future physical architecture for the MAG region was mapped out. This architecture translates the processes and data flows identified in the logical MAG architecture into physical systems, communications, and institutional arrangements. **Figure 1** illustrates the key steps and components of this process.

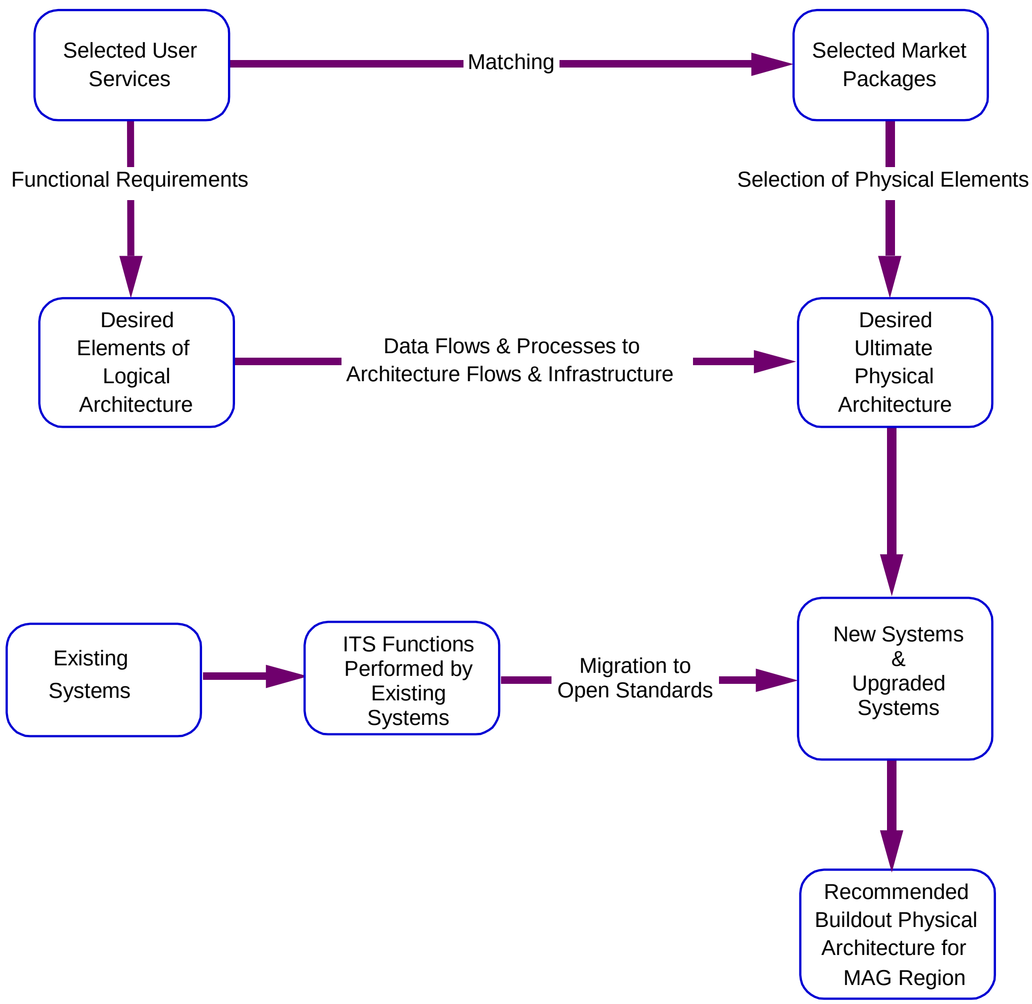
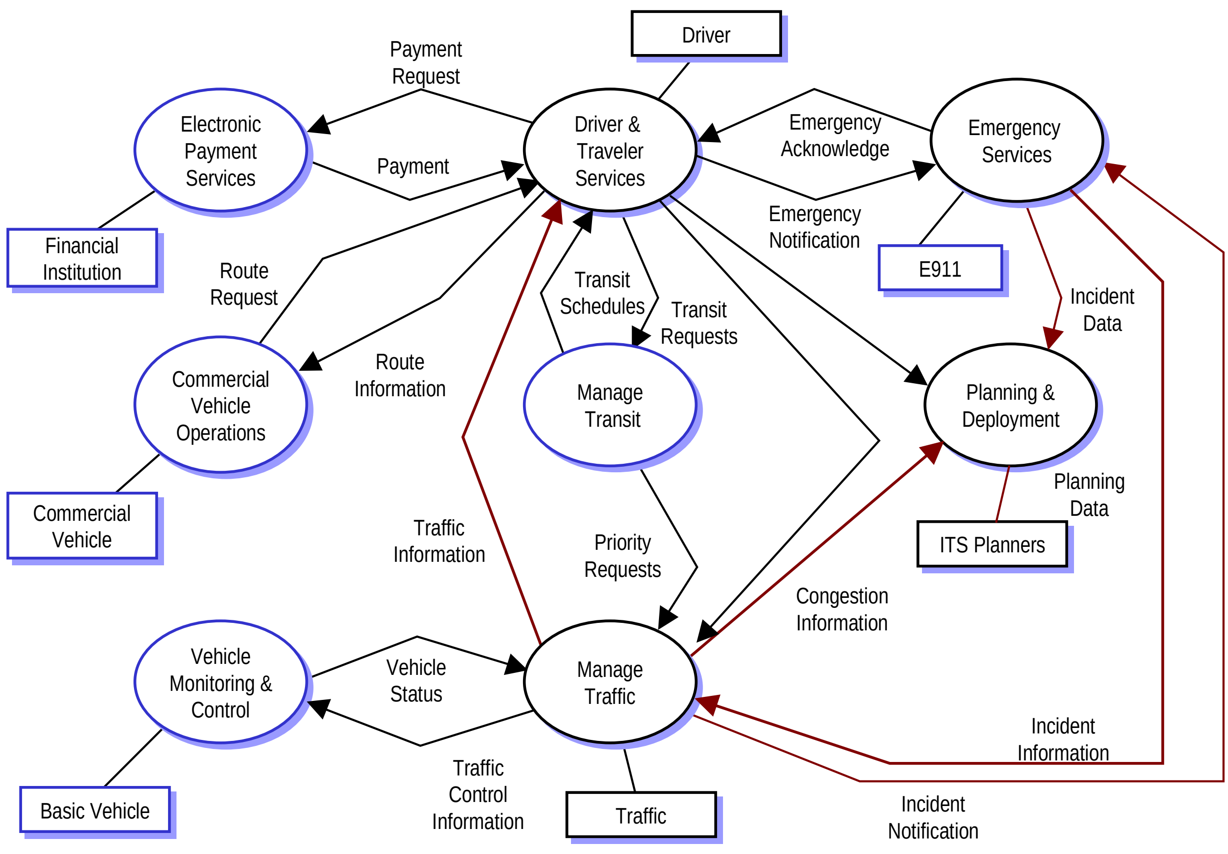


Figure 1 – Major Architecture Development Steps

4.0 LOGICAL ARCHITECTURE

The logical framework of MAG's regional ITS defines the processes and data flows that are needed to provide the user services identified earlier in the MAG ITS Strategic Plan Update. It is the most abstract of all the steps involved in the development of MAG's ITS architecture framework. The development of a logical architecture is removed from any hardware or software constraints and gives the system planner the freedom necessary to ensure that all processes and data needed to support the future MAG ITS are included in the architecture. **Figure 2** depicts a generalized, top-level logical architecture, with processes depicted as the bubbles and data flows labeled along the connecting arrows.



Source: National ITS Architecture

Figure 2 – Generalized Top Level Logical Architecture

The development of a logical system architecture is a complex, iterative process, which typically employs CASE tools[1] software to facilitate tracking of the hundreds possible processes and thousands of data flows, along with all the process terminators, data sinks and stores. The National ITS Architecture Team has developed an exhaustive logical architecture framework which can be used as a "generic" set of processes and data flows from which to extract a concise set of elements needed to define the regional MAG architecture.

This task took advantage of the National ITS Architecture and its frameworks to simplify the development of MAG's logical architecture and ensure consistency with the ITS National Architecture. In order to avoid the very large number of logical architecture diagrams representing processes and data flows at various levels of decomposition, a tabular listing of Level 2 National ITS Architecture processes was used.

The processes needed in the buildout MAG system were selected and are listed in **Table 1**. It should be noted that most of the Level 2 processes have associated subprocesses and data flows, as illustrated on the examples below:

- 1 Manage Traffic (Level 1 Process)
- 1.2 Provide Device Control 1.2 (Level 2 Process - Included in **Table 1**)
- 1.2.1 Select Strategy (Level 3 Process Specification - Not Included in **Table 1**)
- 1.2.2 Determine Road and Freeway State (Level 3 Process - Not Included in **Table 1**)
- 1.2.2.1 Determine Indicator State for Freeway Management (Level 4 Process Specification - Not Included in **Table 1**)

The basis for the selection of logical processes were the user service objectives defined in Technical Memorandum No. 4. These user service objectives define a broad focus of the future MAG ITS and directly represent the needs of the system users. The ITS processes needed to support those user service objectives were selected from the National ITS Architecture. **Selection of the associated subprocesses and data flows is implied.**

Of the seven user service objectives defined in Technical Memorandum No. 6, six were used to select the logical processes shown in **Table 1**. The seventh user service objective, "develop and facilitate ITS education and marketing", is not associated with the processes and data flows described in the logical architecture and therefore is not included.

Table 1 outlines a set of logical processes that, together and when implemented, are anticipated to fulfill the transportation needs identified earlier in this project. As the MAG ITS develops, system implementers are expected to use the appropriate processes and data flows, supplemented by the corresponding lower levels of processes and data flows, as well as processes inherent to their institution to build and maintain a regionally integrated transportation system. The processes identified against user service objectives would result in a future system that would provide the desired functions. However, not all processes are expected to be supported by MAG member agencies or by public sector infrastructure. **Table 1** identifies which processes closely match public sector functions, private sector functions, and those processes that are likely to be supported through public-private partnerships.

[1] CASE stands for "Computer Aided Software Engineering". CASE tools have been adapted for "system" development and could be defined more generically as "Computer Aided System Engineering".

Table 1 - Logical ITS Processes for MAG

LOGICAL ARCHITECTURE PROCESSES (From National ITS Architecture)	Public	Private	Public-Private	PRINCIPAL USER SERVICE OBJECTIVES[(1)] Collect, process and disseminate accurate and up-to-date traveler information	Provide safe and efficient flow of traffic	Improve incident detection and clearance capabilities	Improve transit performance	Improve automated traffic data collection and archival ability	Improve inter and intra agency coordination and cooperation and
1 MANAGE TRAFFIC									
1.1 Provide Traffic Surveillance	X			X	X	X		X	
1.2 Provide Device Control	X			X	X	X		X	
1.3 Manage Incidents	X			X	X	X			X
1.4 Manage Travel Demand	X			X	X			X	X
1.5 Manage Emissions	X				X			X	
1.6 Manage Highway Rail Intersections	X				X	X			X
2 MANAGE COMMERCIAL VEHICLES									
2.1 Manage Commercial Vehicle Fleet Operations		X							X
2.2 Manage Commercial Vehicle Driver Operations		X							
2.3 Provide Commercial Vehicle Roadside Facilities	X	X	X						
2.4 Provide Commercial Vehicle Data Collection	X	X						X	X
2.5 Administer Commercial Vehicles	X	X							X
2.6 Provide Commercial Vehicle On-board Data		X	X						X
2.7 Manage Cargo		X							
3 PROVIDE VEHICLE MONITORING AND CONTROL									
3.1 Monitor Vehicle Status		X			X	X			
3.2 Provide Automatic Vehicle Operation									
3.3 Provide Automatic Emergency Notification		X			X	X			X
3.4 Enhance Driver's Vision		X			X				
4 MANAGE TRANSIT									
4.1 Operate Vehicles and Facilities	X						X		
4.2 Plan and Schedule Transit Services	X				X		X		X
4.3 Schedule Transit Vehicle Maintenance	X				X		X		
4.4 Support Security and Coordination	X					X	X	X	X
4.5 Generate Transit Driver Schedules	X			X	X		X		
4.6 Collect Transit Fares in the Vehicle	X						X		
4.7 Provide Transit User Roadside Facilities	X			X			X		
5 MANAGE EMERGENCY SERVICES									
5.1 Provide Emergency Service Allocation	X								
5.2 Provide Operator Interface for Emergency Data	X								
5.3 Manage Emergency Vehicles	X					X			
5.4 Provide Law Enforcement Allocation	X					X			
5.5 Update Emergency Display Map Data	X			X		X			X
5.6 Manage Emergency Services Data	X			X		X			
6 PROVIDE DRIVER AND TRAVELER SERVICES									
6.1 Provide Trip Planning Services	X	X	X	X	X	X	X	X	X
6.2 Provide Information Services	X	X	X	X	X	X	X	X	X
6.3 Provide Traveler Services at Kiosks	X	X	X	X		X	X		
6.4 Manage Ridesharing	X			X	X		X		X
6.5 Manage Yellow Pages Services		X	X	X					X
6.6 Provide Guidance and Trip Planning Services		X	X	X	X	X	X		X

Table 1 - Logical ITS Processes for MAG

LOGICAL ARCHITECTURE PROCESSES (From National ITS Architecture)	Public	Private	Public-Private	**PRINCIPAL USER SERVICE OBJECTIVES[(1)]** Collect, process and disseminate accurate and up-to-date traveler information	Provide safe and efficient flow of traffic	Improve incident detection and clearance capabilities	Improve transit performance	Improve automated traffic data collection and archival ability	Improve inter and intra agency coordination and cooperation and
6.7 Provide Driver Personal Services		X		X		X			
6.8 Provide Traveler Personal Services		X		X			X		
7 PROVIDE ELECTRONIC PAYMENT SERVICES									
7.1 Provide Electronic Toll Payment	X	X	X						
7.2 Provide Electronic Parking Payment	X	X	X		X				
7.3 Provide Electronic Fare Collection	X	X	X		X		X		
7.4 Carry-out Centralized Payments Processing	X	X			X				
7.5 Provide Payment Instrument Interfaces	X	X			X				
8 MANAGE ARCHIVED DATA									
8.1 Get Archive Data	X				X	X	X	X	X
8.2 Manage Archive	X				X	X	X	X	X
8.3 Manage Archive Data Administrator Interface	X							X	X
8.4 Coordinate Archives	X				X			X	X
8.5 Process Archived Data User System Requests	X				X			X	X
8.6 Analyze Archive	X				X	X	X	X	X
8.7 Process On Demand Archive Requests	X				X			X	X
8.8 Prepare Government Reporting Inputs	X							X	X
8.9 Manage Roadside Data Collection	X		X		X			X	X

[(1)]Principal User Services defined in Technical Memorandum Number 4, except ITS Education and Training which is addressed elsewhere.

5.0 PHYSICAL ARCHITECTURE

5.1 Physical Architecture Definition

The physical architecture focuses on the physical entities and interfaces of the system. It defines the functionality of physical subsystems and communication interfaces among those subsystems. The physical architecture is comprised of the transportation and communications layers, operating in the context of the institutional layer, as shown in **Figure 3**.

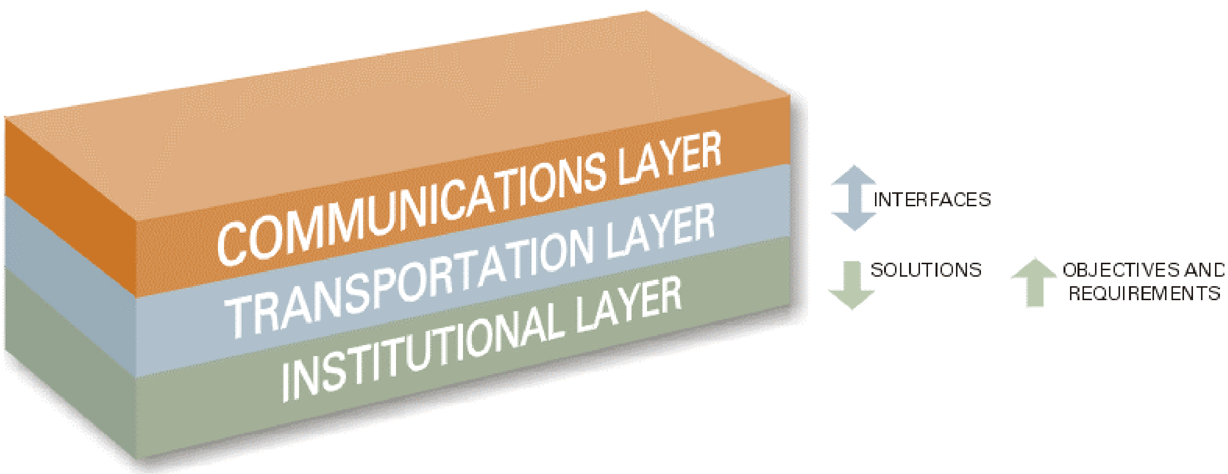
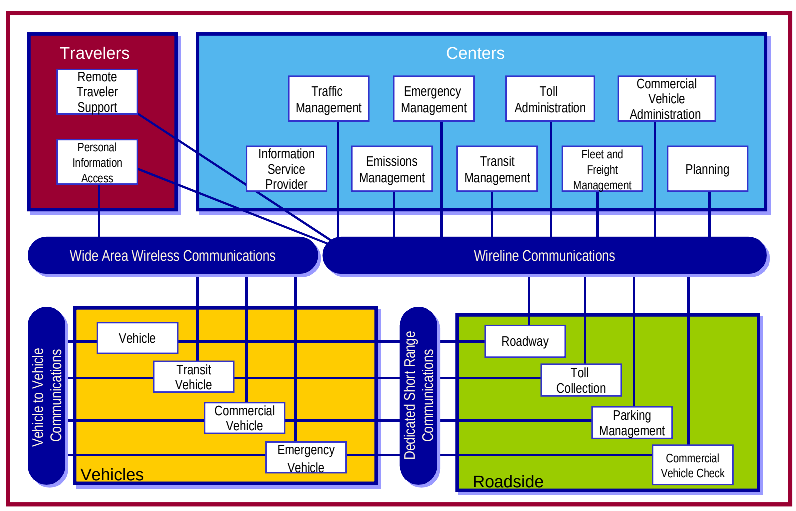


Figure 3 - Physical Architecture Layers

The transportation layer includes various processing centers, roadside equipment, vehicle equipment , and other equipment used by the traveler to access ITS services and information. The typical representation of the transportation layer is through the National ITS Architecture Interconnect Diagram, illustrated in **Figure 4**. In this diagram, elements of the transportation layer, represented by 19 subsystems, are grouped into four distinct subsystem classes: Centers, Roadside, Vehicles, and Travelers. The diagram also illustrates the principal communication paths between the subsystems. The National ITS Architecture Interconnect Diagram is used later in this Technical Memorandum to



Source: National ITS Architecture

Figure 4 - Architecture Interconnect Diagram

graphically summarize both the existing and recommended physical architecture elements for MAG ITS.

The communication layer provides for the transfer of information between the transportation layer elements. The transportation and communication layers, together, are the framework that coordinates overall system operation by defining interfaces between equipment which may be deployed by different procuring and operating sectors.

The institutional layer introduces the policies, funding incentives, working arrangements, and jurisdictional structures that support the technical layers of the architecture.

The MAG physical architecture focuses on the transportation layer; with the top-level view of the communication layer being inherent in this physical architecture. A more detailed definition of the recommended communication architecture will be provided separately in the Technical Memorandum Number 7, ITS Telecommunications Plan.

5.2 Existing MAG ITS Physical Architecture

5.2.1 Transportation Layer

To define the existing MAG ITS infrastructure in terms of the physical architecture, the level of deployment in the MAG region was compared against the 19 subsystems as identified in the ITS National Architecture. A description of the 19 subsystems is provided in **Appendix A**. Technical Memorandum Number 3 of the MAG ITS Strategic Plan Update provided an inventory of the existing ITS systems in the MAG region. This inventory was matched against the 19 subsystems to determine the status of the existing subsystem implementation in the MAG region.

Implementation status is defined as follows:

- ***Full Implementation*** - Subsystem has been fully implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future;
- ***Partial Implementation*** - Subsystem has been partially implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future;
- ***Low/Planning/Design Phase of Implementation*** - Subsystem is at a low level of implementation or is currently being planned or designed for implementation;
- ***No Implementation*** - Subsystem has been identified as appropriate for the agency, however plans do not exist for implementation of this subsystem; and
- ***N/A*** - Agency will not have primary responsibility for implementation of subsystem.

The existing level of subsystem implementation in the MAG region is shown in **Table 2**.

Table 2 – Status of Future Subsystem Implementation in the MAG Region

	Subsystems																		
	Centers									Roadside				Traveler		Vehicle			
Responsible Agency	Regional Archived Data Mgmt Sys	Commercial Vehicle Admin	Emergency Management	Emissions Management	Fleet and Freight Management	Information Service Provider	Toll Administration	Traffic Management	Transit Management	Commercial Vehicle Check	Parking Management	Roadway	Toll Collection	Personal Info Access	Remote Traveler Support	Commercial Vehicle	Emergency Vehicle	Transit Vehicle	Vehicle
MAG[1]	◐	○	◐	◐	◐	◐	N/A	◐	◐	◐	○	◐	N/A	◐	◐	◐	◐	◐	◐
RPTA[1]	◌	N/A	N/A	N/A	N/A	◐	N/A	N/A	◐	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
ADOT	◐	○	◐	◐	○	◐	N/A	◐	N/A	◐	N/A	◐	N/A	N/A	◐	N/A	◐	N/A	N/A
MCDOT	○	N/A	○	◐	○	◐	N/A	◐	N/A	N/A	○	◐	N/A	N/A	◐	N/A	◌	N/A	N/A
Chandler Traffic	◌	N/A	N/A	N/A	N/A	◐	N/A	◐	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Gilbert Traffic	◌	N/A	N/A	N/A	N/A	◐	N/A	○	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Glendale Traffic	◌	N/A	N/A	N/A	N/A	◐	N/A	○	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Mesa Traffic	◌	N/A	N/A	N/A	N/A	◐	N/A	◐	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Paradise Valley Traffic	◌	N/A	N/A	N/A	N/A	◌	N/A	◐	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Peoria Traffic	◌	N/A	N/A	N/A	N/A	◌	N/A	○	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Phoenix Traffic	◌	N/A	N/A	N/A	N/A	○	N/A	◐	N/A	N/A	◐	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Scottsdale Traffic	◌	N/A	N/A	N/A	N/A	○	N/A	◐	N/A	N/A	◌	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
Tempe Traffic	◌	N/A	N/A	N/A	N/A	◐	N/A	◐	N/A	N/A	○	◐	N/A	N/A	◐	N/A	N/A	N/A	N/A
New ITS Cities Traffic	◌	N/A	N/A	N/A	N/A	◌	N/A	◌	N/A	N/A	◌	◌	N/A	N/A	◌	N/A	N/A	N/A	N/A
Glendale Transit	◌	N/A	N/A	N/A	N/A	◌	N/A	N/A	◌	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
Mesa Transit	◌	N/A	N/A	N/A	N/A	◌	N/A	N/A	◐	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
Peoria Transit	◌	N/A	N/A	N/A	N/A	◌	N/A	N/A	◌	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
Phoenix Transit	◌	N/A	N/A	N/A	N/A	◐	N/A	N/A	◐	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
Scottsdale Transit	◌	N/A	N/A	N/A	N/A	◌	N/A	N/A	◐	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
Tempe Transit	◌	N/A	N/A	N/A	N/A	◌	N/A	N/A	◐	N/A	N/A	○	N/A	○	◐	N/A	N/A	◐	N/A
DPS	N/A	N/A	○	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	◐	N/A	◌	N/A	N/A
MC Sheriff's Office	N/A	N/A	○	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	◌	N/A	◌	N/A	N/A
Local Police	N/A	N/A	◐	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	◌	N/A	◐	N/A	N/A
Fire	N/A	N/A	◐	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	◌	N/A	◐	N/A	N/A
PSAPs	N/A	N/A	◐	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	◌	N/A	N/A	N/A	N/A
Airports	N/A	N/A	N/A	N/A	N/A	◐	N/A	N/A	N/A	N/A	○	◌	N/A	N/A	◐	N/A	N/A	N/A	N/A
MC Flood Control	N/A	N/A	◌	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	○	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Private Sector	◌	◌	◐	N/A	◐	◐	N/A	N/A	N/A	N/A	◌	◌	N/A	◐	◐	◐	N/A	N/A	◐

[1]Indicates the role of MAG and RPTA in coordination, funding, and policy making of subsystem implementation.

● - Full Implementation (Subsystem has been fully implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future.)

◐ - Partial Implementation (Subsystem has been partially implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future.)

○ - Low/Planning/Design Phase of Implementation (Subsystem is at a low level of implementation or is currently being planned or designed for implementation.)

◌ - No Implementation (Subsystem has been identified as appropriate for the agency, however plans do not exist for implementation of this subsystem.)

N/A - Not Applicable (Agency will not have primary responsibility for implementation of subsystem.)

Based on the existing level of subsystem implementation, the existing physical architecture for the MAG region was developed. The existing Statewide ITS Architecture for Arizona and the AZTech™ architecture were reviewed to ensure that the existing MAG architecture adequately reflected these systems. The existing MAG ITS architecture was developed in such a format that it is easily traceable to the National ITS Architecture Interconnect Diagram. In presenting the existing architecture in this manner, the existing ITS deployments in the MAG region may be easily traced to the National ITS Architecture. The existing architecture for the MAG region is presented in **Figure 5**.

5.2.2 Communications

The communications layer of the existing MAG ITS architecture is inherent in **Figure 5**. The communications layer provides the foundation for the interconnection of the subsystems and is essential for an integrated system. Four basic types of communications systems are displayed:

- Wireline Communications;
- Wide Area Wireless Communication;
- Dedicated Short Range Communications; and
- Vehicle to Vehicle Communications.

Technical Memorandum Number 7, ITS Telecommunications Plan, will describe in greater detail the existing communications infrastructure in the MAG region and provide a plan for future deployment.

5.2.3 Institutional Integration

Some of the needed capability to implement the MAG region's intelligent transportation infrastructure is in place and operational. State, regional, and local jurisdictions throughout the region had to take several deliberate, positive strides in order to create a truly regional transportation system. Collaborative efforts include the Metropolitan Area Governments Information Center (MAGIC) study in 1994, and the ITS Strategic Plan for Early Deployment for Maricopa County in 1995. These efforts brought agencies throughout the area together to approach traffic management and long-range transportation planning from a regional perspective. The AZTech™ Model Deployment Initiative then followed this in 1996-1999. Prior to the AZTech™ MDI the basis of "peer-to-peer-with-permissive-control" for the public/public partnerships was established and AZTech™ built on that sound and successful foundation to strengthen and expand the coalition to the private sector. In total, more than 40 agencies and private companies formed the AZTech™ coalition. The institutional framework established during the AZTech™ deployment phase was focused on fast-track deployment and is illustrated in **Figure 6**.

Existing MAG ITS Physical Architecture

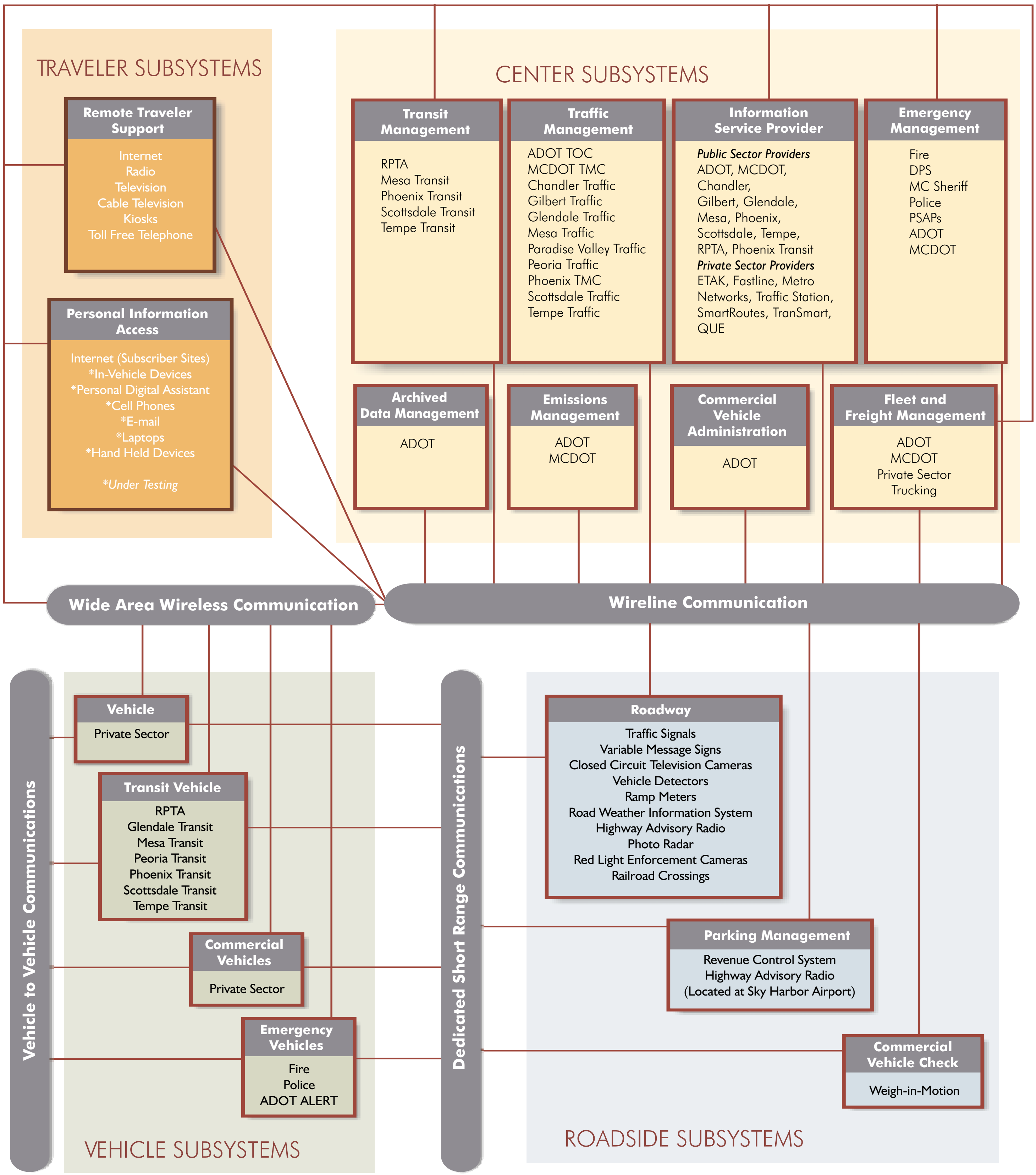


Figure 5

Kimley-Horn and Associates, Inc.

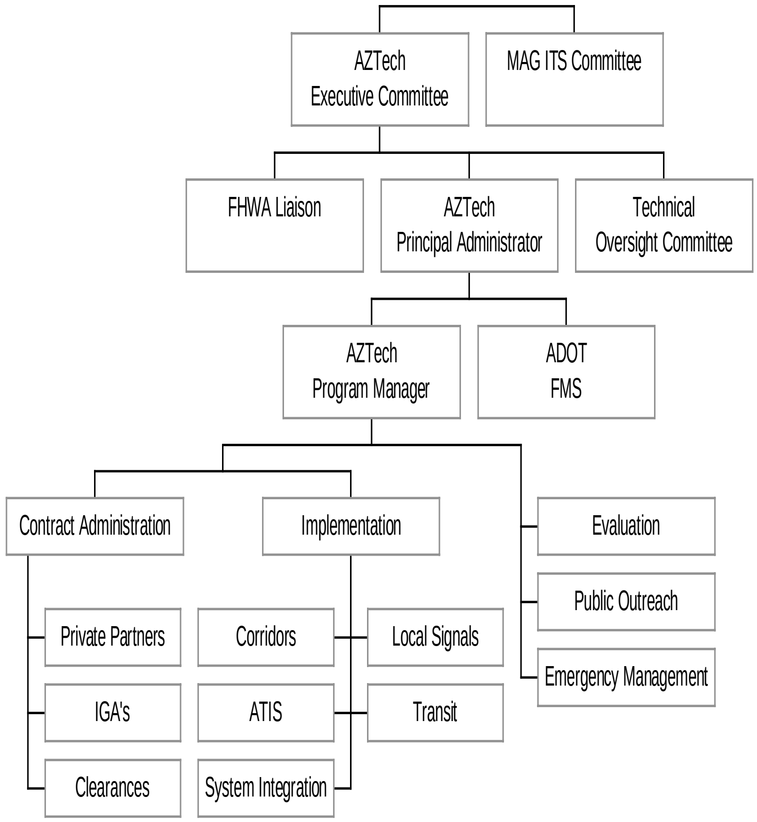


Figure 6 – Regional Institutional Framework During the AZTech™ Deployment Phase

Subsequent to the deployment of the AZTech™ infrastructure and services, the institutional arrangements changed to accommodate the modified needs of the stakeholders in the MAG region. The current institutional framework in the MAG region is shown in **Figure 7**. The AZTech™ organizational structure has been streamlined to address the on-going support of the system and to expand the existing infrastructure and services. The MAG ITS Committee has assumed the overall planning, coordinating and funding responsibility for the region's ITS program and has among other activities initiated an update of the 1995 ITS Strategic Plan. The ADOT FMS has continued its currently funded expansion of the FMS through separate funding sources; however, the MAG ITS Committee has assumed the responsibility for future prioritization of the FMS. The current institutional arrangements are successful because of the solid foundation of cooperation that was laid over the last six years. An institutional layer that supports the technological and communications layers of the future MAG Regional ITS architecture demands complete institutional integration to realize the full benefits of a fully developed and integrated ITS infrastructure in the MAG region.

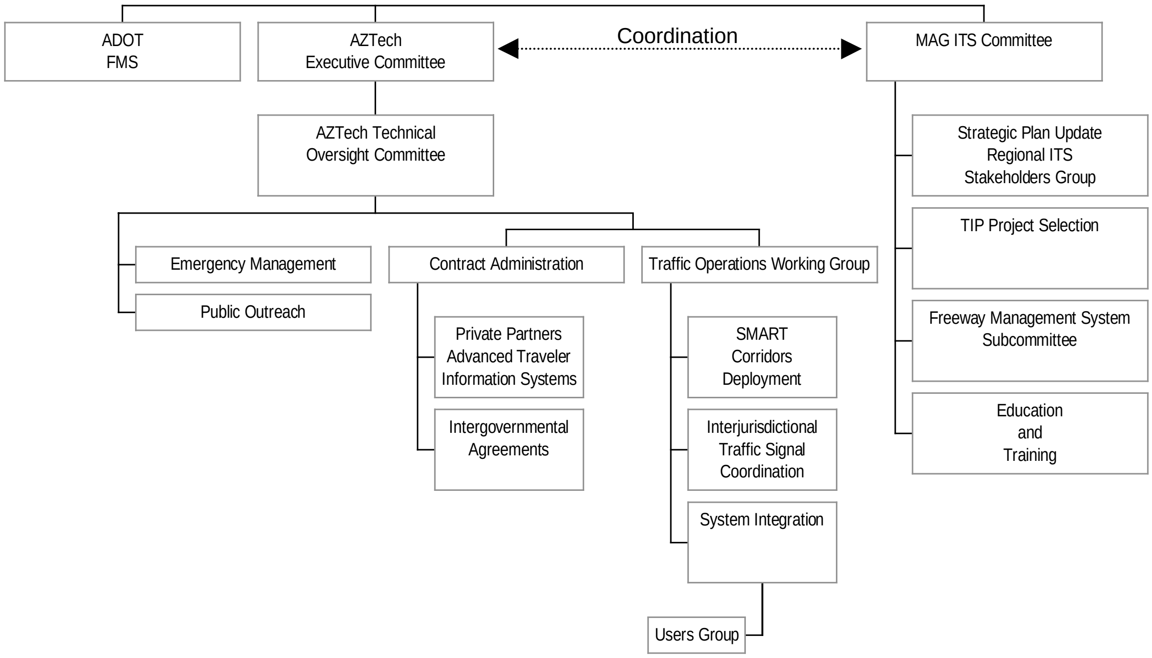


Figure 7 – Current Regional ITS Institutional Framework

5.3 Recommended Future MAG ITS Physical Architecture

5.3.1 Transportation Layer

The future MAG ITS architecture was developed based on the identified stakeholder needs and their corresponding User Services and Market Packages. These User Services and Market Packages were defined in Technical Memorandum Number 4. The future ITS architecture for the MAG region must be designed to allow the implementation of each of the Market Packages in an integrated fashion. "Future" is defined as the end of the long-term implementation phase, which has be identified as the year 2021.

Before developing the future ITS architecture, the future subsystems that should be implemented by the agencies in the MAG region were defined. A high level of deployment is envisioned for each of the subsystems in the future in order to fully deploy identified market packages and ultimately satisfy the identified user needs in the MAG region. **Table 3**, Recommended Future Subsystem Implementation in the MAG Region, displays the high level of implementation recommended for each subsystem and the agencies to which they are matched.

Table 3 – Status of Future Subsystem Implementation in the MAG Region

	Subsystems																		
	Centers									Roadside				Traveler		Vehicle			
Responsible Agency	Regional Archived Data Mgmt Sys	Commercial Vehicle Admin	Emergency Management	Emissions Management	Fleet and Freight Management	Information Service Provider	Toll Administration	Traffic Management	Transit Management	Commercial Vehicle Check	Parking Management	Roadway	Toll Collection	Personal Info Access	Remote Traveler Support	Commercial Vehicle	Emergency Vehicle	Transit Vehicle	Vehicle
MAG[1]	●	●	●	●	●	●	N/A	●	●	●	●	●	N/A	●	●	●	●	●	●
RPTA[1]	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
ADOT	●	●	●	●	●	●	N/A	●	N/A	●	N/A	●	N/A	N/A	●	N/A	●	N/A	N/A
MCDOT	●	N/A	●	●	●	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	●	N/A	N/A
Chandler Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Gilbert Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Glendale Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Mesa Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Paradise Valley Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Peoria Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Phoenix Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Scottsdale Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Tempe Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
New ITS Cities Traffic	●	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
Glendale Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
Mesa Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
Peoria Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
Phoenix Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
Scottsdale Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
Tempe Transit	●	N/A	N/A	N/A	N/A	●	N/A	N/A	●	N/A	N/A	●	N/A	●	●	N/A	N/A	●	N/A
DPS	N/A	N/A	●	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A
MC Sheriff's Office	N/A	N/A	●	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A
Local Police	N/A	N/A	●	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A
Fire	N/A	N/A	●	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	●	N/A	N/A
PSAPs	N/A	N/A	●	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	N/A	N/A	N/A
Airports	N/A	N/A	N/A	N/A	N/A	●	N/A	N/A	N/A	N/A	●	●	N/A	N/A	●	N/A	N/A	N/A	N/A
MC Flood Control	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Private Sector	●	●	●	N/A	●	●	N/A	N/A	N/A	N/A	●	●	N/A	●	●	●	N/A	N/A	●

[1]Indicates the role of MAG and RPTA in coordination, funding, and policy making of subsystem implementation.

● - Full Implementation (Subsystem has been fully implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future.)

◐ - Partial Implementation (Subsystem has been partially implemented to the level of functionality and coverage desired by the agency, and additional deployments of subsystem components will be added as needed or as funding becomes available in the future.)

○ - Low/Planning/Design Phase of Implementation (Subsystem is at a low level of implementation or is currently being planned or designed for implementation.)

◌ - No Implementation (Subsystem has been identified as appropriate for the agency, however plans do not exist for implementation of this subsystem.)

N/A - Not Applicable (Agency will not have primary responsibility for implementation of subsystem.)

Building on the recommended subsystem implementation, a future MAG ITS architecture was developed. The future MAG ITS architecture is displayed similar to the National ITS Architecture Interconnect Diagram to allow an easy traceability from the MAG ITS Architecture to the National ITS Architecture. The future MAG ITS architecture is displayed in **Figure 8**.

To tailor the future MAG ITS Architecture and further define certain elements of the architecture, an architecture "vision" diagram was developed. The MAG Regional ITS Architecture Vision is provided in **Figure 9**.

The MAG Regional ITS Architecture Vision groups the subsystems into four classes: Center Subsystems, Roadside Subsystems, Vehicle Subsystems, and Traveler Subsystems. Each of the subsystem classes is identified as public or private, which represents the sector that will be responsible for the deployment.

The MAG regional architecture vision provides for the addition of such future components as new roadside technologies, new vehicle subsystem technologies, new traveler subsystems, and the addition of new ITS cities to the center subsystems. As technologies evolve and smaller cities in the MAG region grow and develop their ITS programs, it is important that these technologies and cities are incorporated into the regional architecture.

Also identified in the MAG Regional ITS Architecture is a system to assume the current functions of the separate FMS, AZTech™, and Highway Closure and Restriction System/Road Closure and Restriction System (HCRS/RCRS) servers.

The MAG ITS Implementation Plan, which will be presented in Technical Memorandum Number 6, will describe the projects and funding necessary to achieve the architecture vision. Short-term (2002-2006), mid-term (2007-2011) and long-term (2012-2021) projects will be identified. The level of implementation of the of the architecture vision during each of these time frames also will be identified.

Future MAG ITS Physical Architecture

MARICOPA ASSOCIATION of GOVERNMENTS

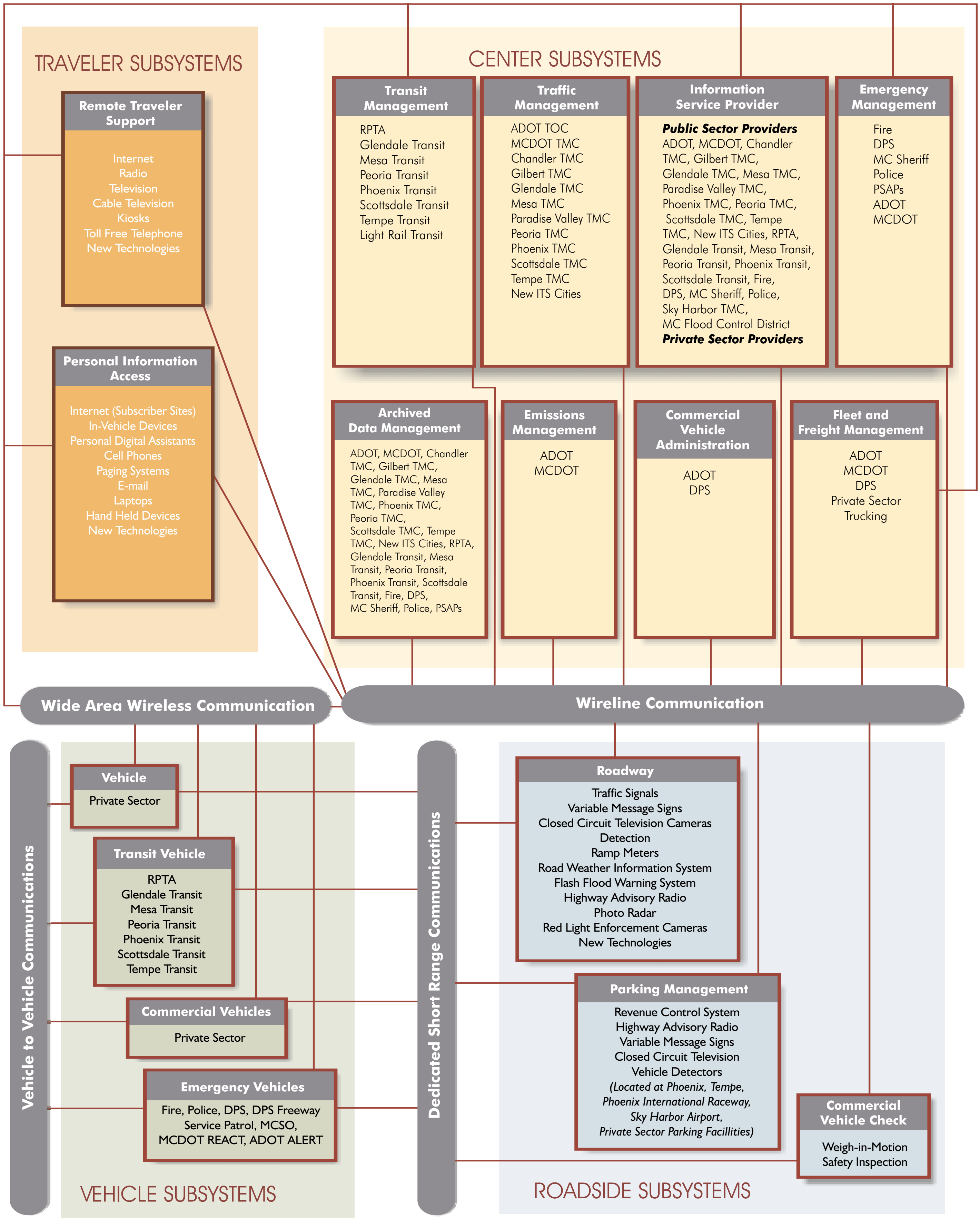


Figure 8

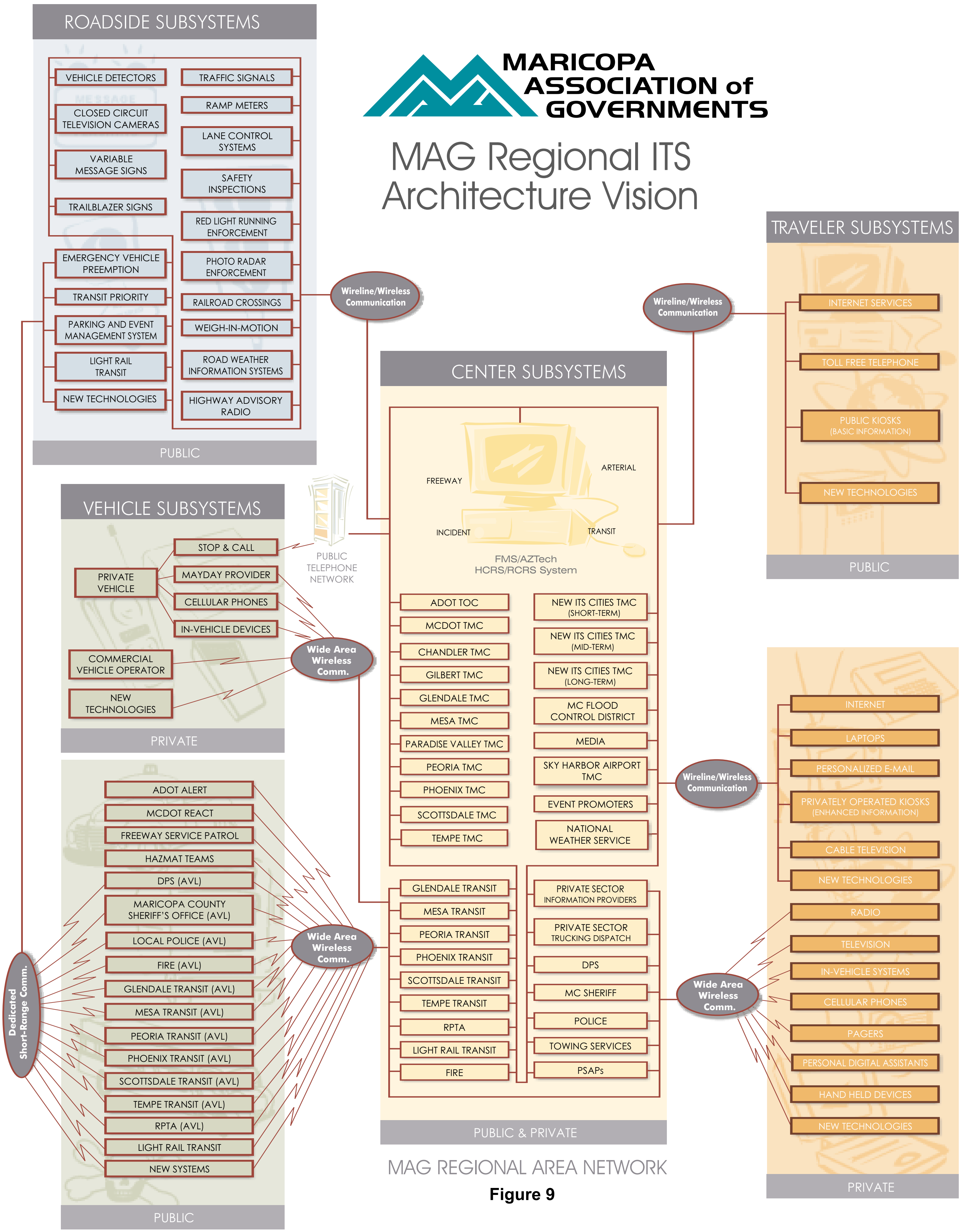

MARICOPA ASSOCIATION of GOVERNMENTS
MAG Regional ITS Architecture Vision
ROADSIDE SUBSYSTEMS
VEHICLE DETECTORS
CLOSED CIRCUIT TELEVISION CAMERAS
VARIABLE MESSAGE SIGNS
TRAILBLAZER SIGNS
EMERGENCY VEHICLE PREEMPTION
TRANSIT PRIORITY
PARKING AND EVENT MANAGEMENT SYSTEM
LIGHT RAIL TRANSIT
NEW TECHNOLOGIES
TRAFFIC SIGNALS
RAMP METERS
LANE CONTROL SYSTEMS
SAFETY INSPECTIONS
RED LIGHT RUNNING ENFORCEMENT
PHOTO RADAR ENFORCEMENT
RAILROAD CROSSINGS
WEIGH-IN-MOTION
ROAD WEATHER INFORMATION SYSTEMS
HIGHWAY ADVISORY RADIO
PUBLIC
Wireline/Wireless Communication
VEHICLE SUBSYSTEMS
PRIVATE VEHICLE
STOP & CALL
MAYDAY PROVIDER
CELLULAR PHONES
IN-VEHICLE DEVICES
COMMERCIAL VEHICLE OPERATOR
NEW TECHNOLOGIES
PRIVATE
PUBLIC TELEPHONE NETWORK
Wide Area Wireless Comm.
ADOT ALERT
MCDOT REACT
FREEWAY SERVICE PATROL
HAZMAT TEAMS
DPS (AVL)
MARICOPA COUNTY SHERIFF'S OFFICE (AVL)
LOCAL POLICE (AVL)
FIRE (AVL)
GLENDALE TRANSIT (AVL)
MESA TRANSIT (AVL)
PEORIA TRANSIT (AVL)
PHOENIX TRANSIT (AVL)
SCOTTSDALE TRANSIT (AVL)
TEMPE TRANSIT (AVL)
RPTA (AVL)
LIGHT RAIL TRANSIT
NEW SYSTEMS
PUBLIC
Dedicated Short-Range Comm.
Wide Area Wireless Comm.
CENTER SUBSYSTEMS
FREEWAY
ARTERIAL
INCIDENT
TRANSIT
FMS/AZTech
HCRS/RCRS System
ADOT TOC
MCDOT TMC
CHANDLER TMC
GILBERT TMC
GLENDALE TMC
MESA TMC
PARADISE VALLEY TMC
PEORIA TMC
PHOENIX TMC
SCOTTSDALE TMC
TEMPE TMC
NEW ITS CITIES TMC (SHORT-TERM)
NEW ITS CITIES TMC (MID-TERM)
NEW ITS CITIES TMC (LONG-TERM)
MC FLOOD CONTROL DISTRICT
MEDIA
SKY HARBOR AIRPORT TMC
EVENT PROMOTERS
NATIONAL WEATHER SERVICE
GLENDALE TRANSIT
MESA TRANSIT
PEORIA TRANSIT
PHOENIX TRANSIT
SCOTTSDALE TRANSIT
TEMPE TRANSIT
RPTA
LIGHT RAIL TRANSIT
FIRE
PRIVATE SECTOR INFORMATION PROVIDERS
PRIVATE SECTOR TRUCKING DISPATCH
DPS
MC SHERIFF
POLICE
TOWING SERVICES
PSAPs
PUBLIC & PRIVATE
Wireline/Wireless Communication
TRAVELER SUBSYSTEMS
INTERNET SERVICES
TOLL FREE TELEPHONE
PUBLIC KIOSKS (BASIC INFORMATION)
NEW TECHNOLOGIES
PUBLIC
Wireline/Wireless Communication
INTERNET
LAPTOPS
PERSONALIZED E-MAIL
PRIVATELY OPERATED KIOSKS (ENHANCED INFORMATION)
CABLE TELEVISION
NEW TECHNOLOGIES
Wide Area Wireless Comm.
RADIO
TELEVISION
IN-VEHICLE SYSTEMS
CELLULAR PHONES
PAGERS
PERSONAL DIGITAL ASSISTANTS
HAND HELD DEVICES
NEW TECHNOLOGIES
PRIVATE
MAG REGIONAL AREA NETWORK

Figure 9

5.3.2 Communications

Both the Future ITS Physical Architecture (**Figure 8**) and the MAG Regional ITS Architecture Vision (**Figure 9**) identify communications infrastructure that will be used to connect the subsystems. While communications technologies will certainly evolve in the future, it is expected that the basic types of communications (e.g., wireline, wide-area wireless, dedicated short-range) will remain the same.

Technical Memorandum Number 7, ITS Telecommunications Plan, will describe in greater detail the types of communications infrastructure that must be deployed in order to achieve the MAG regional architecture vision.

5.3.3 Future Institutional Arrangements

To support the regional ITS architecture, a new regional ITS institutional framework has been adopted and is shown in **Figure 10**. The future institutional framework focuses on the planning and operations of ITS, and requires close coordination between these two functions.

The MAG Regional Council, Management Committee, Transportation Review Committee and ITS Committee will have primary responsibilities for ITS planning in the region. Specific responsibilities of these groups will include:

- Regional infrastructure planning;
- Regional operations planning;
- Regional standards and architecture;
- Performance measures and evaluation;
- Regional telecommunications infrastructure;
- Public outreach; and
- Training and capacity building.

The AZTech™ Executive Committee and Transportation Operations Working Group will have primary responsibility for regional ITS operations. Specific operational responsibilities of the AZTech™ Executive Committee and Transportation Operations Working Group will include:

- Incident management coordination;
- Signal timing;
- Traveler information services;
- Transit operations;
- Traffic management coordination;
- Event management;
- Parking management;
- Regional transportation network management;
- Public outreach; and
- Training and capacity building.

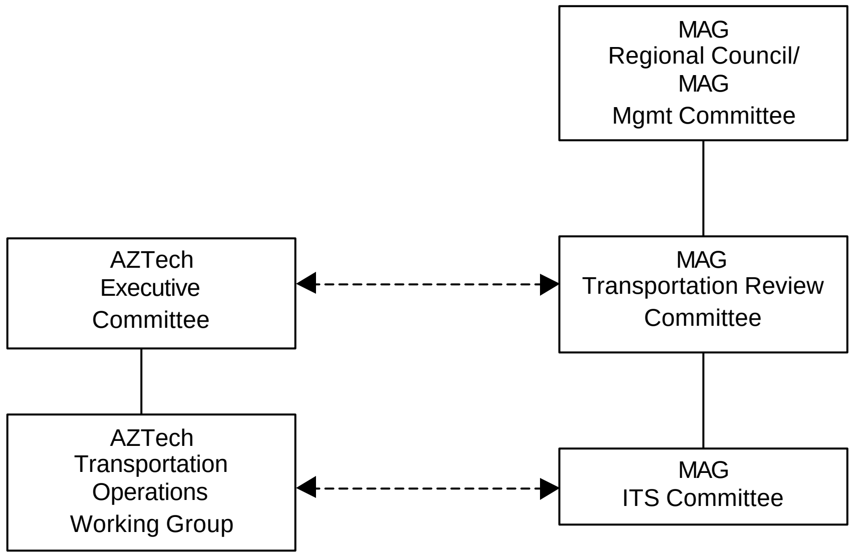


Figure 10 – Future Regional ITS Institutional Framework

Close coordination between planning and operational groups is critical to the successful deployments of ITS in the region. Planning must consider how ITS will be operated and ensure that resources are available to adequately operate and maintain the systems that are planned. Operational groups must coordinate with planners to ensure that projects which are planned meet operational needs and that the resources are available to operate and maintain planned projects. In the future institutional framework for the MAG region, the AZTech™ Executive Committee and the MAG Transportation Review Committee will coordinate activities. Similarly, the AZTech™ Transportation Operations Working Group and the MAG ITS Committee will coordinate activities.

APPENDIX A - NATIONAL ITS ARCHITECTURE SUBSYSTEMS

CENTER SUBSYSTEMS

Archived Data Management Subsystem

The Archived Data Management Subsystem collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications. The data received is formatted, tagged with attributes that define the data source, conditions under which it was collected, data transformations, and other information (i.e. meta data) necessary to interpret the data. The subsystem can fuse ITS generated data with data from non-ITS sources and other archives to generate information products utilizing data from multiple functional areas, modes, and jurisdictions. The subsystem prepares data products that can serve as inputs to Federal, State, and local data reporting systems. This subsystem may be implemented in many different ways. It may reside within an operational center and provide focused access to a particular agency's data archives. Alternatively, it may operate as a distinct center that collects data from multiple agencies and sources and provides a general data warehouse service for a region.

Commercial Vehicle Administration Subsystem

The Commercial Vehicle Administration Subsystem will operate at one or more fixed locations within a region. This subsystem performs administrative functions supporting credentials, tax, and safety regulations. It issues credentials, collects fees and taxes, and supports enforcement of credential requirements. This subsystem communicates with the Fleet Management Subsystems associated with the motor carriers to process credentials applications and collect fuel taxes, weight/distance taxes, and other taxes and fees associated with commercial vehicle operations. The subsystem also receives applications for, and issues special Oversize/Overweight and HAZMAT permits in coordination with other cognizant authorities. The subsystem coordinates with other Commercial Vehicle Administration Subsystems (in other states/regions) to support nationwide access to credentials and safety information for administration and enforcement functions. This subsystem supports communications with Commercial Vehicle Check Subsystems operating at the roadside to enable credential checking and safety information collection. The collected safety information is processed, stored, and made available to qualified stakeholders to identify carriers and drivers that operate unsafely.

Emergency Management Subsystem

The Emergency Management Subsystem operates in various emergency centers supporting public safety including police and fire stations, search and rescue special detachments, and HAZMAT response teams. This subsystem interfaces with other Emergency Management Subsystems to support coordinated emergency response involving multiple agencies. The subsystem creates, stores, and utilizes emergency response plans to facilitate coordinated response. The subsystem tracks and manages emergency vehicle fleets using automated vehicle location technology and two way communications with the vehicle fleet. Real-time traffic information received from the other center subsystems is used to further aide the emergency dispatcher in selecting the emergency vehicle(s) and routes that will provide the most timely response. Interface with the Traffic Management Subsystem allows strategic coordination in tailoring traffic control to support en-route emergency vehicles. Interface with the Transit Management Subsystem allows coordinated use of transit vehicles to facilitate response to major emergencies.

Emissions Management Subsystem

This subsystem operates at a fixed location and may co-reside with the Traffic Management Subsystem or may operate in its own distinct location depending on regional preferences and priorities. This subsystem provides the capabilities for air quality managers to monitor and manage air quality. These capabilities include collecting emissions data from distributed emissions sensors within the roadway subsystem. These sensors monitor general air quality within each sector of the area and also monitor the emissions of individual vehicles on the roadway. The sector emissions measures are collected, processed, and used to identify sectors exceeding safe pollution levels. This information is provided to toll administration, traffic management, and transit management systems and used to implement strategies intended to reduce emissions in and around the problem areas. Emissions data associated with individual vehicles, supplied by the Roadway Subsystem, is also processed and monitored to identify vehicles that exceed standards. This subsystem provides any functions necessary to inform the violators and otherwise ensure timely compliance with the emissions standards.

Fleet and Freight Management Subsystem

The Fleet and Freight Management Subsystem provides the capability for commercial drivers and dispatchers to receive real-time routing information and access databases containing vehicle and cargo locations as well as carrier, vehicle, cargo, and driver information. In addition, the capability to purchase credentials electronically shall be provided , with automated and efficient connections to financial institutions and regulatory agencies, along with post-trip automated mileage and fuel usage reporting. The Fleet Management Subsystem also provides the capability for Fleet Managers to monitor the safety of their commercial vehicle drivers and fleet. The subsystem also supports application for HAZMAT credentials and makes information about HAZMAT cargo available to agencies as required.

Information Service Provider Subsystem

This subsystem collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The subsystem can play several different roles in an integrated ITS. In one role, the ISP provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the ISP provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. The second role of an ISP is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories, real time traffic condition and transit schedule information, yellow pages information, ridematching information, and parking information. The subsystem also provides the capability to provide specific directions to travelers by receiving origin and destination requests from travelers, generating route plans, and returning the calculated plans to the users. In addition to general route planning for travelers, the ISP also supports specialized route planning for vehicle fleets. In this third role, the ISP function may be dedicated to, or even embedded within, the dispatch system. Reservation services are also provided in advanced implementations. The information is provided to the traveler through the Personal Information Access Subsystem, Remote Traveler Support Subsystem, and various Vehicle Subsystems through available communications links. Both basic one-way (broadcast) and personalized two-way information provision is supported. The subsystem provides the capability for an informational infrastructure to connect providers and consumers, and gather that market information needed to assist in the planning of service improvements and in maintenance of operations.

Toll Administration Subsystem

The Toll Administration Subsystem provides general payment administration capabilities and supports the electronic transfer of authenticated funds from the customer to the transportation system operator. This subsystem supports traveler enrollment and collection of both pre-payment and post-payment transportation fees in coordination with the existing, and evolving financial infrastructure supporting electronic payment transactions. The system may establish and administer escrow accounts depending on the clearinghouse scheme and the type of payments involved. This subsystem posts a transaction to the customer account and generates a bill (for post-payment accounts), debits an escrow account, or interfaces to the financial infrastructure to debit a customer designated account. It supports communications with the Toll Collection Subsystem to support fee collection operations. The subsystem also sets and administers the pricing structures and includes the capability to implement road pricing policies in coordination with the Traffic Management Subsystem. The electronic financial transactions in which this subsystem is an intermediary between the customer and the financial infrastructure shall be cryptographically protected and authenticated to preserve privacy and ensure authenticity and auditability.

Traffic Management Subsystem

The Traffic Management Subsystem operates within a traffic management center or other fixed location. This subsystem communicates with the Roadway Subsystem to monitor and manage traffic flow. Incidents are detected and verified and incident information is provided to the Emergency Management Subsystem, travelers (through Roadway Subsystem Highway Advisory Radio and Dynamic Message Signs), and to third party providers. The subsystem supports HOV lane management and coordination, road pricing, and other demand management policies that can alleviate congestion and influence mode selection. The subsystem monitors and manages maintenance work and disseminates maintenance work schedules and road closures. The subsystem also manages reversible lane facilities, and processes probe vehicle information. The subsystem communicates with other Traffic Management Subsystems to coordinate traffic information and control strategies in neighboring jurisdictions. It also coordinates with rail operations to support safer and more efficient highway traffic management at highway-rail intersections. Finally, the Traffic Management Subsystem provides the capabilities to exercise control over those devices utilized for AHS traffic and vehicle control.

Transit Management Subsystem

The transit management subsystem manages transit vehicle fleets and coordinates with other modes and transportation services. It provides operations, maintenance, customer information, planning and management functions for the transit property. It spans distinct central dispatch and garage management systems and supports the spectrum of fixed route, flexible route, and paratransit services. The subsystem's interfaces allow for communication between transit departments and with other operating entities such as emergency response services and traffic management systems. This subsystem receives special event and real-time incident data from the traffic management subsystem. It provides current transit operations data to other center subsystems. The Transit Management Subsystem collects and stores accurate ridership levels and implements corresponding fare structures. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and assigns drivers and maintenance personnel to vehicles and routes. The Transit Management Subsystem also provides the capability for automated planning and scheduling of public transit operations. It furnishes travelers with real-time travel information, continuously updated schedules, schedule adherence information, transfer options, and transit routes and fares. In addition, the monitoring of key transit locations with both video and audio systems is provided with automatic alerting of operators and police of potential incidents including support for traveler activated alarms.

ROADSIDE SUBSYSTEMS

Commercial Vehicle Check Subsystem

The Commercial Vehicle Check Subsystem supports automated vehicle identification at mainline speeds for credential checking, roadside safety inspections, and weigh-in-motion using two-way data exchange. These capabilities include providing warnings to the commercial vehicle drivers, their fleet managers, and proper authorities of any safety problems that have been identified, accessing and examining historical safety data, and automatically deciding whether to allow the vehicle to pass or require it to stop with operator manual override. The Commercial Vehicle Check Subsystem also provides supplemental inspection services to current capabilities by supporting expedited brake inspections, the use of operator hand-held devices, on-board safety database access, and the enrollment of vehicles and carriers in the electronic clearance program.

Parking Management Subsystem

The Parking Management Subsystem provides electronic monitoring and management of parking facilities. It supports a DSRC communications link to the Vehicle Subsystem that allows electronic collection of parking fees. It also includes the instrumentation, signs, and other infrastructure that monitors parking lot usage and provides local information about parking availability and other general parking information. This portion of the subsystem functionality must be located in the parking facility where it can monitor, classify, and share information with customers and their vehicles. The subsystem also interfaces with the financial infrastructure and broadly disseminates parking information to other operational centers in the region. Note that the latter functionality may be located in a back office, remote from the parking facility.

Roadway Subsystem

This subsystem includes the equipment distributed on and along the roadway which monitors and controls traffic. Equipment includes highway advisory radios, dynamic message signs, cellular call boxes, CCTV cameras and video image processing systems for incident detection and verification, vehicle detectors, traffic signals, grade crossing warning systems, and freeway ramp metering systems. This subsystem also provides the capability for emissions and environmental condition monitoring including weather sensors, pavement icing sensors, fog etc. HOV lane management and reversible lane management functions are also available. In advanced implementations, this subsystem supports automated vehicle safety systems by safely controlling access to and egress from an Automated Highway System through monitoring of, and communications with, AHS vehicles. Intersection collision avoidance functions are provided by determining the probability of a collision in the intersection and sending appropriate warnings and/or control actions to the approaching vehicles.

Toll Collection Subsystem

The Toll Collection Subsystem provides the capability for vehicle operators to pay tolls without stopping their vehicles using locally determined pricing structures and including the capability to implement various variable road pricing policies. Each transaction is accompanied by feedback to the customer which indicates the general status of the customer account. A record of the transactions is provided to the Toll Administration subsystem for reconciliation and so that the customer can periodically receive a detailed record of the transactions.

TRAVELER SUBSYSTEMS

Personal Information Access Subsystem

This subsystem provides the capability for travelers to receive formatted traffic advisories from their homes, place of work, major trip generation sites, personal portable devices, and over multiple types of electronic media. These capabilities shall also provide basic routing information and allow users to select those transportation modes that allow them to avoid congestion, or more advanced capabilities to allow users to specify those transportation parameters that are unique to their individual needs and receive travel information. This subsystem shall provide capabilities to receive route planning from the infrastructure at fixed locations such as in their homes, their place of work, and at mobile locations such as from personal portable devices and in the vehicle or perform the route planning process at a mobile information access location. This subsystem shall also provide the capability to initiate a distress signal and cancel a prior issued manual request for help.

Remote Traveler Support Subsystem

This subsystem provides access to traveler information at transit stations, transit stops, other fixed sites along travel routes, and at major trip generation locations such as special event centers, hotels, office complexes, amusement parks, and theaters. Traveler information access points include kiosks and informational displays supporting varied levels of interaction and information access. At transit stops, simple displays providing schedule information and imminent arrival signals can be provided. This basic information may be extended to include multi-modal information including traffic conditions and transit schedules along with yellow pages information to support mode and route selection at major trip generation sites. Personalized route planning and route guidance information can also be provided based on criteria supplied by the traveler. In addition to traveler information provision, this subsystem also supports public safety monitoring using CCTV cameras or other surveillance equipment and emergency notification within these public areas. Fare card maintenance, and other features which enhance traveler convenience may also be provided at the discretion of the deploying agency.

VEHICLE SUBSYSTEMS

Commercial Vehicle Subsystem

This subsystem resides in a commercial vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient commercial vehicle operations. The Commercial Vehicle Subsystem provides two-way communications between the commercial vehicle drivers, their fleet managers, and roadside officials, and provides HAZMAT response teams with timely and accurate cargo contents information after a vehicle incident. This subsystem provides the capability to collect and process vehicle, cargo, and driver safety data and status and alert the driver whenever there is a potential safety problem. Basic identification and safety status data are supplied to inspection facilities at mainline speeds. In addition, the subsystem will automatically collect and record mileage, fuel usage, and border crossings.

Emergency Vehicle Subsystem

This subsystem resides in an emergency vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient emergency response. The Emergency Vehicle Subsystem includes two-way communications to support coordinated response to emergencies in accordance with an associated Emergency Management Subsystem. Emergency vehicles are equipped with automated vehicle location capability for monitoring by vehicle tracking and fleet management functions in the Emergency Management Subsystem. Using these capabilities, the appropriate emergency vehicle to respond to each emergency is determined. Route guidance capabilities within the vehicle enable safe and efficient routing to the emergency. In addition, the emergency vehicle may be equipped to support signal preemption through communications with the roadside subsystem.

Transit Vehicle Subsystem

This subsystem resides in a transit vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient movement of passengers. The Transit Vehicle Subsystem collects accurate ridership levels and supports electronic fare collection. An optional traffic signal prioritization function communicates with the roadside subsystem to improve on-schedule performance. Automated vehicle location functions enhance the information available to the Transit Management Subsystem enabling more efficient operations. On-board sensors support transit vehicle maintenance. The Transit Vehicle Subsystem also furnishes travelers with real-time travel information, continuously updated schedules, transfer options, routes, and fares.

Vehicle Subsystem

This subsystem resides in an automobile and provides the sensory, processing, storage, and communications functions necessary to support efficient, safe, and convenient travel by personal automobile. Information services provide the driver with current travel conditions and the availability of services along the route and at the destination. Both one-way and two-way communications options support a spectrum of information services from low-cost broadcast services to advanced, pay for use personalized information services. Route guidance capabilities assist in formulation of an optimal route and step by step guidance along the travel route. Advanced sensors, processors, enhanced driver interfaces, and actuators complement the driver information services so that, in addition to making informed mode and route selections, the driver travels these routes in a safer and more consistent manner. Initial collision avoidance functions provide “vigilant co-pilot” driver warning capabilities. More advanced functions assume limited control of the vehicle to maintain safe headway. Ultimately, this subsystem supports completely automated vehicle operation through advanced communications with other vehicles in the vicinity and in coordination with supporting infrastructure subsystems. Pre-crash safety systems are deployed and emergency notification messages are issued when unavoidable collisions do occur.